Chapter III

Recommended Actions for the Air Force

What to Do and What to Stop Doing

Resources to Get There and How to Make It Happen

1.0 Introduction

Up to this point, this Summary Volume has presented a list of essential capabilities for the Air Force of the 21st century and provided rationale as to why. The purpose of this Chapter is to propose to the Air Force a top level summary of what technology groups should be developed to produce Air Force future capabilities necessary for it to continue into the 21st century as the world's best and most respected. As described in Chapter II, these six capabilities are outlined as follows:

- Global Awareness
- Dynamic Planning and Execution Control
- Global Mobility in War and Peace
- Projection of Lethal and Sublethal Power
- Space Operations
- People

In the interest of brevity, our intent is to suggest the major "leap ahead" technology areas that need to be pursued. We have referenced the Panel Volumes by footnotes, and the readers are asked to consult the appropriate Panel Volume for details. Those volumes are the major works of *New World Vistas*. They contain the details needed to build and execute specific research programs. After recommendations on what to do in each of the capabilities mentioned above, recommendations, where appropriate, on what to stop doing or not to do will be provided to help focus time and resources. And finally, after the discussions on what to do and if needed, what not to do, will come a funding proposal to get the effort started in the right direction and a suggestion concerning how to track matters to see that the undertaking remains *on course and on glide path.* We shall begin with consideration of the six generic capabilities mentioned above.

2.0 What the Air Force Should Do

2.1 Global Awareness

A future goal of the Air Force should be to know at all times the relevant global military situation given the existing political and economic conditions and the state of military conflict. Such awareness should be in near real time (in time enough to understand and act) and with near real perfect knowledge (knowledge good enough to make good decisions in the time available to decide and act). This is the idea of Global Awareness. Some will argue, and we do not disagree, that this is or is not a part of Information Warfare. In this regard, we recognize the importance of Information Warfare in the future and that much of what we present in this summary volume is Information Warfare said another way. The key technologies to make Global Awareness possible lie in the right mix and integration of sensors, communications, and processing to collect data and convert it into information and knowledge in a meaningful time frame over the area of interest. The reader is invited to study closely the Information Technology, Information Applications, Sensors, Space Applications, and Space Technology volumes of this study for details. A top level list of the relevant technologies are outlined without comment as follows:

- Clusters of cooperating satellites
  - Precision station keeping
  - Autonomous satellite operations
  - Signal processing for sparse apertures
- Laser cross and down links
- Precise global positioning, time transfer, and mapping[1]
- Large, sensitive focal plane arrays and associated read out
- Radiation resistant satellites and components
- Spectral sensing at all relevant wavelengths
- Active sensors
  - Large light weight antennas
  - High efficiency radio frequency sources
  - High energy lasers
- Micro-electro-mechanical systems[2]
- Communications and networking
- Automated fusion[3]
- Automated target recognition[4]

2.2 Dynamic Planning and Execution Control

The first step toward acquisition of Dynamic Planning and Execution Control capability is to *make this idea or concept part of Air Force and Joint Doctrine*. Next is to *pursue a joint architecture* definition to implement the doctrine. The concept of Dynamic Planning and Execution Control is to exploit the Global Awareness acquired through the technologies just listed above. As such, this idea will make possible the most efficient use of the mobility, power projection, space operations and people associated with the military capabilities of the United States. The attainment of relevant Global Awareness and its exploitation through Dynamic Planning and Execution Control will be a high leverage capability to win America's future wars quickly, decisively, with minimum or no human losses (on both sides). As with Global Awareness and the capabilities in this chapter, this topic is replete with information warfare aspects and can be viewed in that context as well as in the functional categories used for this presentation. The following technologies summary applies to support Dynamic Planning and Execution Control:

1. Space Applications Volume
2. Sensors Volume
3. Information Applications Volume
4. Sensors Volume

- Support for Planning. Faster than real time interactive, predictive, continuous running simulations for planning and mission rehearsal will the driving technology for planning side for future employment of air and space power.
- Support to mission execution. Execution of the plan is where the true flexibility and speed of employment of air and space power will be realized. Technologies which permit near real time changes and updates to on-board databases as well as other planning and situational awareness databases will be key. Rapid capture of information from on-board sensors, including the crew, into these databases will also be very important. Finally, concurrent faster than real time simulations for near real time mission execution, planning, and attack will insure we remain inside any enemy's timeline for action.

2.3 Global Mobility in War and Peace

The United States military has a long tradition of going where necessary in the world to conduct military and peaceful operations. Such a capability will perhaps be even more important in the 21st century. The Air Force brings speed and reach to the global mobility equation. The current introduction of the C-17 will serve the country well as we enter the next millennium. The following technology areas are recommended to make a difference in the use of the C-17 and after the C-17.

- *Point of Use Delivery*. The idea here is that supplies delivered by aerial transport should be delivered directly to where they are to be used without landing the transport aircraft. Delivery of medical supplies beside the hospitals, food directly to the soldier or feeding facility, and weapon system load and reload ammunition to the weapon in its firing position are possible examples. Secure dependable communications, precision airdrop, multi- spectral sensors for weather and intelligence, intransit visibility of cargo, aircraft situational awareness and aircraft self protection are the key technologies.
- *Low Cost Precision Airdrop*. A key driver in making "point of use delivery" possible will be the need for a low cost way to dispense air cargo in modules, containers, or pallets with appropriate guidance, control and arresting mechanisms. A proper balance of expendable and reusable components is needed to achieve the results within a reasonable cost.
- *The "Million Pound" Airlifter*. Thinking needs to begin now for the next generation airlifter. High lift over drag wing/airframe design and testing needs to begin. Engineered materials[5], high temperature engine components, composite fabrication and fastening, and next generation material for airframe and skin are needed.

2.4 Projection of Lethal and Sublethal Power

The four major technology directions that the Air Force should pursue to project lethal and sublethal power in the 21st century are outlined as follows. There is a fifth technology having to do with Space, but it will be covered later in the Space Operations section of this chapter.

5. Mobility Volume

- *Uninhabited Combat Aerial Vehicles (UCAV).* As this technology is developed it will offer potential for significantly more capable weapon systems at lower cost. Such vehicles serendipitously accommodate the probably inexorable trend of American society which are more and more expecting no human losses during U. S. military operations. The technologies to realize the UCAV include new high efficiency, high supersonic engines; advanced structures; avionics, control systems, and observables; very high altitude/low speed cruise, very small/miniaturized "micro-air vehicles"; very high dynamic pressure cruise vehicles; intelligent signal and data processing; secure and possibly redundant control data links; control science and applications for mission and vehicle management of a complex, highly coupled system, control criteria to achieve optimal performance based on that used for missile control; and human/machine interface for off board air vehicle control.
- *High Power Microwave and High Power Laser Directed Energy Weapons.* Speed of light weapons with the full spectrum capability to deny, disrupt, degrade and/or destroy will leap past and could eventually replace many traditional explosive driven weapons and self protection countermeasure systems. There are five innovative technologies required for "energy frugal" practical directed energy weapons.[6,7] They are large, lightweight optics, HPM antennas using thin membrane fabrication; high-power short-wavelength solid-state lasers; high average-power phase conjugation; new approaches to adaptive optics and phased arrays of diode lasers.
- *Stealth-the Next Plateau.* Active radio frequency and next generation passive infrared stealth capability will replace what we have today with another quantum leap forward in vehicle survivability.
- *Hypersonic Air Breathing Platforms/Vehicles.* Even with the tremendous increase in space operations in the future there will continue to be a major place for air breathing platforms/vehicles. Time is now, always has been, and even more so in the information age future, will be of the essence in military operations especially those of the Air Force. All distances on the earth are fixed. If the Air Force is to execute faster than an enemy in the 21st century, then to reduce time, the only alternative is to go faster. Hypersonic air breathing flight is as natural as supersonic flight. Advanced cycle, dual mode ramjet/scramjet engines and high temperature, lighter weight materials which allow for long range, long endurance, high altitude supercruise are the enabling technologies.[8]

2.5 Space Operations

Space operations will grow rapidly as a factor in United States military capabilities limited primarily by affordable access. Space operations already contribute much to global observation and global situational awareness. Space control and projection of force from space technologies will become as important in the 21st century as space becomes more available to many countries of the world.

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6. Directed Energy Volume
7. Space Technology Volume
8. Aircraft and Propulsion Volume

- *Access to Space*. Affordable access to space will require many advances in technology. Such technology includes lower mass of the components for power, energy storage and conversion, attitude control, propulsion, large-thrust, high-specific impulse chemical propulsion, multi-functional structures that integrate spacecraft bus functions into the structure of the spacecraft itself, high temperature materials, ultra-light-weight integrated cryogenic structures and miniaturized sensors.
- *Global Observation and Situational Awareness*. Sensors, the conversion of sensor data to information and knowledge, the necessary communications to move the data, information and knowledge when and where needed are necessary for global observation and situational awareness. Although such activity may be conducted in both the air and space medium, the use of space will continue to grow and begin to dominate in the 21st century. The technical trades and costs associated with global observation and situational awareness from either air or space will have to be made as the decisions to replace or improve current capabilities are faced. In the mean time, there are many technologies needed regardless of whether the job is done from air or space. These technologies are outlined in the previous section on Global Awareness.
- *Space Control Technologies*. The Air Force must begin to think and bring forward the technologies necessary for space control. Capabilities to defend our own space based resources and to disrupt, degrade, deny or destroy that of the enemy will be needed sooner or later in the 21st century. The technologies needed to protect our space resources from enemies include high thrust, high specific impulse electric propulsion, large constellations of low cost satellites with distributed functionality or networking across the system and autonomous guidance & navigation.
- *Force Projection from Space*. The laser directed energy weapon mentioned above in the "Projection of Lethal and Sub-lethal Power" section may be employed from space. Alternatively, the laser can be ground based with directing mirrors deployed in space. Short wavelength, electric lasers along with large optics and antenna technology will be needed. In addition, for space deployment of the laser, large electrical prime power such as nuclear or power beaming along with power storage in advanced capacitors or secondary advanced flywheels will need to be pursued. The sensor, communications and autonomous guidance and navigation technology needs mentioned above will contribute to force projection from space.

2.6 People

There can be no question as we enter the 21st century that the idea of the individual's central importance will continue to be a driving force in our culture. As such, the expectation of the American people (perhaps unrealistic but nonetheless powerful) is that there should be almost no casualties during the conduct of military operations. In addition to the capabilities and technologies mentioned above, attention must be paid to the technologies which will improve the human part of the military capability equation. Those entrusted with the defense of our country must be well trained, able to control and work with machines and information systems in the most efficient way and be mentally and physically superior within moral and ethical

bounds to any enemy. The five human-related technology areas that will allow significant improvements in human performance are summarized as follows.[9]

- *Training.* Training can be significantly improved and made less expensive through personnel selection and classification technologies which more closely match skills and aptitudes to the task. In addition, interactive individual and group training using virtual reality and other distributed interactive simulation where appropriate will be the training technologies of the 21st century.
- *Human/Machine System Fusion*. Voice recognition and voice generation, gesture recognition and response, multi-lingual translation and generation and brain control of computer technologies will all contribute to making sure that the human is not the limiting factor in rapid exploitation of Global Awareness through Dynamic Planning and Execution Control.
- *Operational.* In order to better understand, design and operate the weapon systems of the next century a more detailed understanding of the human is needed. Technologies associated with cognitive and non-cognitive models of the human learner and of the instructional process are needed. Such understanding not only will help with the training needs listed above, but will make possible the most cost effective human machine fusion in such areas as displays and controls, brain control of computers, etc.
- *Biological*. Technologies which temporarily enhance human performance and provide for emergency mission extension should be developed. The technologies should be brought forward into capabilities under the social and ethical standards of our country and leave no short or long term after effects. It is expected these capabilities will only be used on the most difficult and dangerous missions. We owe with proper controls, such capability to our people who must do the military job just as much as we do the best tank, ship or aircraft if we truly believe that wars are best fought to win quickly, decisively and with no or minimum human losses.
- *Scientific and Technical Personnel Management.* Air Force leadership from the days of General Hap Arnold to the current Chief and the Secretary recognize that science and technology is the life force of our country's air and space capability. We must have a path for more scientific and technical officers to attain the highest positions in our Air Force. We, therefore, recommend that the Air Force officers who command laboratories be given the status and be treated in the promotion system like other operational wing commanders. Please refer to Chapter IV on "Organizational Considerations" for more on the management of Air Force scientific and technical personnel.

9. Human Systems/Biotechnology Volume

3.0 What the Air Force Should Not Do or Stop Doing

Much work and study has gone into how the Air Force can leverage its science and technology resources with the technologies the commercial world will bring forward to the Air Force in the coming years. There are also technologies or development initiatives internal to the Air Force which have little chance of being converted to actual capabilities. With this in mind, the following is a representative summary list (which is probably incomplete) of technologies the Air Force should stop doing all together or at least by itself.

- Stop Buying Bandwidth to the Theater
- Stop Software Development of Software Tools
- Stop Development of Compiliers
- Stop Mandatory Use of Ada
- Stop Selective Availability of GPS
- Stop Environmental Protection Research in Air Force Labs
- Stop Aircraft Cockpit Design Work - Depend on aircraft manufacturers
- Stop Ejection Seat research and development - Depend on aircraft manufacturers
- Rethink MILSTAR
- Stop Military Only Launch Access to Space - Exploit commercial systems
- Rethink the design of and investment in dedicated Military Satellite Communication Systems[10]

Defocus Air Force investments to utilize commercial and university developments in the following areas:

- High capacity communications “backbones”; global telephone networks; world-wide wireless infrastructure, Internet, ATM
- Cryptography routinely embedded in systems
- Compression (except intelligent compression)

In some areas, the Air Force laboratories should recast themselves as *users* of commercial and university research, rather than basic developers. These areas include:

- Multimedia technologies
- Natural Language Understanding, including Speech Understanding
- Computer displays
- Data mediators, request facilitators, information broker software

10. Chapter II, Sec. 3.3

- Basic directed-action software agents
- Software for the "business" functions of the AF: logistics, personnel, finance, etc.

For example, the Air Force may make heavy use of commercial smart agents within its command and control systems. However, the core research in these areas is best left to the university and commercial communities.

As with many things in life, the decision on what to stop doing is not simple. Complicating factors include a sincere entrenched bureaucracy which will resist.

We recommend that the Air Force establish an independent, outside panel to review priorities of S&T programs. A concentrated effort should be made to eliminate 5% of S&T programs each year. Funds for the discontinued programs can be applied to new programs.

4.0 Resources to Get There

We recommend that the Air Force invest 15% of its S&T resources over the next five years in new start S&T areas directly related to *New World Vistas* proposed technologies. Such an investment policy will do two things. First it will cause the Air Force to invest in long term key technologies which are not under the current mandate of immediate short term pay off. Such activity will make possible the longer term view needed to create the quantum leaps in capability in the next century. Second, such a policy will act as a forcing function on what to stop or curtail to find the resources for the longer term investments.

5.0 How to Make "*New World Vistas*" Happen

We recommend the SAB sponsor and coordinate workshops, briefings, SAB member participation on panels and forums, and other appropriate activities to extensively communicate the essence and details of New World Vistas.

We recommend the Principal Deputy Assistant Secretary of the Air Force (Acquisition) (SAF/AQ) be responsible for leading the effort within the Air Force to determine what and how *New World Vistas* is to be implemented and how progress will be measured and tracked.

Chapter IV

Organizational Considerations and Recommendations

1.0 Introduction

New World Vistas describes a new way of combining and integrating Air Force technologies and capabilities. It is natural to assume that the structure and philosophy of the organization must make some concessions. The operational capabilities enabled by the new technologies are closely paralleled by today's capabilities. While the ratio of forces in various commands may change and the equipment and individual tasks may change, the generic functions will be quite similar. It is in the technology and procurement organizations that fundamental change will manifest itself. There should be changes made in personnel practices as well. We will recommend changes that we believe to be constructive and positive. Finally, we will recommend some functional changes within SAB operations.

2.0 Procurement and System Development

Everyone rails at the procurement system as the source of all unjustified expense and interminable delays. We will not repeat the well known arguments. We will only suggest that completion dates have the same status as other specifications of a system. Many of the systems suggested by *New World Vistas* can be built a piece at a time, and funding reductions should be reflected in the extent of the system rather than by extending the procurement time. The systems need to mesh with one another, and, therefore the relative phasing of procurements is important. These considerations suggest that systems be procured in blocks which continuously replace older blocks and continuously insert new technology in later blocks. One can argue that this has been the philosophy of many procurements, and we have chosen the nomenclature to suggest this argument. While this is true to some extent, the procurement cycle time for many of the concepts in *New World Vistas* should be no more than two years, and replacement time for information systems should be no more than 5 years. The system should be redesigned to accommodate these times. It is known in the commercial world that extended development periods lead to excessive costs. The Defense procurement system stretches programs in time so that many programs can be pursued in parallel. Both Government and Contractor have become too comfortable with this situation. We should consider the possibility that programs in series with rapid completion may be more economical.

The existing organization is optimized for the development and procurement of independent systems. It was emphasized many times that the effectiveness and affordability of capabilities depends on their close integration. The ideal situation would be one in which all participants in all procurement and development projects interacted at all times to produce systems which naturally worked together in the most efficient way. The ideal situation is impossible. Even if people could be convinced to behave in the proper way, they would spend so much time cooperating that they could get no work done. While we must instill the importance of the concepts of integration and cooperation of systems in all Air Force people, government and contractor, we must realize that focus on an individual product is the natural tendency of techno-humans.

Therefore, integration and interoperability must be assured at a higher level than that of individual system development and procurement. We recommend that an Integration Authority be established to guarantee integration and interoperability. We use the terms assured and guaranteed rather than dictate to indicate that the function of the Integration Authority is not to hand down specifications. That has been tried before, and it tends to stifle innovation and to stagnate

technology. The specification of Ada is an example. Rather, we envision an Integration Integrated Product Team (IIPT) approach under the command of the Integration Authority. The IIPT would be composed of knowledgeable members of all interacting development projects. They would be responsible for proposing program and system modifications to facilitate integration and interoperability. The teams could also specify common components which could be separated from several projects into a common procurement to reduce cost. The purpose of the IIPT's would be to produce global optimization of systems rather than the sum of local optimizations that we have today.

We believe that the Integration Authority and IIPT approach could produce significant economies even in the short term. Avionics modernization of existing aircraft, and GPS installation in those aircraft are areas where enforced commonality could result in substantial savings Air Force wide.

3.0 Air Force Laboratory Organization

The Air Force Laboratories are now under the control of the AFMC Product Centers. The organization was established because the Labs had become unresponsive to the needs of the operational Air Force. We believe that the decision was correct. The new organization focused the work of the Labs on problems which were important to the Air Force and, simultaneously, gave the Labs enhanced stature in the eyes of the Operational Force. The position of Air Force Technology Executive Officer (AFTEO) was established to coordinate the programs.

We believe that the current organization has served its purpose well, but the pendulum has begun its inexorable swing from improved focus to myopia. Each of the Labs has important programs which are not directly associated with its Product Center. Those programs will eventually suffer because of their being labeled as outsiders. The impact of new technologies is to demand closer integration and "flattening" of organizations to provide better integration of the technologies themselves. Recognizing that no organizational structure remains viable forever, we recommend that all the Laboratories be placed under the authority of an S&T Executive. The S&T Executive should have authority over both personnel and programs. We avoid recommending either civilian or military control. A civilian S&T Executive could provide continuity, but a military S&T Executive could provide closer ties to the operational Air Force. The S&T Executive should be, at least, at the level of a Product Center Commander, but the exact structure and identity of the S&T Executive should be the subject of further debate and study. The S&T Executive should be charged with maintaining the pressure on the S&T organization to recognize and pursue transition opportunities. The executive pressure coupled with better integration across the S&T organization should increase transition opportunities.

4.0 Personnel Practices and Opportunities

We observed that technically educated people will be extremely important to the Air Force of the 21st century.[1] Technology will touch all facets of Air Force life and operations. Although the Air Force can recruit intelligent and productive people by offering funding for advanced and undergraduate degrees, retention of those people will be possible only if career opportunities

1. Chapter II, Sec. 7.0

exist in the long term. For technically educated military personnel, it should be possible to establish a path through the Lab Commander position to Flag rank. The designation of Lab Commander as equivalent to Wing Commander will place the Lab Commander in a promotable position. If Lab Commanders have impeccable technical credentials, the young officer will feel that a technically oriented career has significant advancement possibilities. Fewer will abandon the Force for industrial jobs. We do not suggest that a technically oriented career be pursued only in Laboratories or SPO's. There should be diversification during a career. We suggest only that the majority of a career be devoted to technical matters. *The Air Force should consider career management of technically oriented officers with the same vigor as that of the rated force.*

5.0 SAB Focus

The SAB consists of 50 members. The members are assigned to a Panel such as Sciences, Avionics, etc., but in fact there is no formal organization. A part time, volunteer organization composed of scientists, technologists, and administrators truly has no need of formal organization. There is no evidence that the absence of an enforced formal structure has had any effect at all on the operation of the organization. Members respond to requests for their time to the extent that they can. Their dedication to the organization is indicated by an average yearly participation of more than 20 days. Most find the collegiality and informality of the organization refreshing, and strong friendships develop. Therefore, we believe that the organization, or lack of one, is appropriate.

The tasks performed by the members could be altered somewhat. The Board performs studies at the rate of a large summer study and one or more ad hoc studies each year. Occasionally, a small group of Board members will respond to a specific request for a study requiring three or four members to meet once or twice to consider a specific, limited issue. Also, Mission Panels respond to requests for help from a Major Command once or twice a year. A large portion of the Board's work is directed toward the quality review of Air Force Laboratory programs. We believe that all these functions are appropriate and should be continued.

Over the past few years the Board has provided members to moderate and evaluate the output of two Workshops. The first was the Laser Mission Study which was convened by Phillips Lab at the request of Maj. Gen. Robert Rankine when he was AFTEO. The study was a great success, and its recommendations are being pursued with equal success. Last year, a three day workshop on munitions with a structure similar to the Laser Mission Study was organized at the Munitions Directorate of Wright Lab. It was also judged a success in that it gave direction to Air Force efforts to develop higher energy density explosives and more effective munitions. In January or February 1996, a workshop on atmospheric propagation and compensation of laser beams will be held under the auspices of the SAB, the Naval Research Lab, and Phillips Lab. We expect the workshop to define research directions in the field.

We believe a workshop should be a yearly feature of the SAB. It is not only effective but also it amplifies the work of the Board and produces useful results with less effort on the part of the SAB Secretariat.

We also believe that the “quick look” study could be used more effectively in support of ongoing projects.

Finally, there should be a significant effort in the current year to generate a migration plan for *New World Vistas* technologies and to make the output of the *New World Vistas* study useful input to the Air Force Long Range Planning effort.